ELEMENTARY PARTICLE PHYSICS

Physics 363
KPTC 105 9:00 – 10:20 a.m. [1]
Tuesdays and Thursdays – Spring Quarter 2007
Instructor: J. Rosner, RI 271, 2-7694, rosner@hep.uchicago.edu

The unification of electromagnetic and weak interactions has led to the prediction of many phenomena which have been discovered over the years, such as charge-preserving neutrino interactions; the existence of three new quarks (charm, beauty, and top); the existence of heavy charged and neutral bosons carrying the weak force; and a series of relations among weak coupling constants which are verified at the sub-percent level. A key missing piece in this picture is the Higgs boson, associated with the breaking of electroweak symmetry.

As the number of known quarks increased in the 1970's, 1980's, and 1990's from three to the present total of six, a long-standing mystery associated with the behavior of neutral K mesons was solved. As proposed by Kobayashi and Maskawa (KM) in 1973, a six-quark theory can explain the violation of CP symmetry, first observed in 1964 in the decays of neutral K mesons. The KM theory also predicted large CP-violating effects in decays of B mesons (those containing the beauty quark), which have now been discovered at electron-positron colliders in California and Japan. The KM description of weak couplings of quarks is mirrored by a corresponding pattern for leptons, which differs in interesting details. This pattern leads to the change in "flavor" of neutrinos as they propagate in vacuum or through matter. A wide variety of experiments have addressed these *neutrino oscillations.*

A survey of these programs and their underlying theoretical background will be given in this course. The grade will be based on problem sets (75%) and a final project (25%), due on Tuesday, June 5. Suggestions for the final project will be given during April.

READING LIST

1. Text: Francis Halzen and Alan D. Martin, *Quarks and Leptons: An Introductory Course in Modern Particle Physics,* John Wiley & Sons, 1984, ISBN-0-471-88741-2.

2. Recommended supplementary text: David J. Griffiths, *Introduction to Elementary Particles,* John Wiley & Sons, 1987, ISBN: 0-471-60386-4.

[1] First meeting: 9:00 a.m., Tuesday, Mar. 27.

3. Useful supplementary text: *Gauge Theories of the Strong, Weak, and Electromagnetic Interactions*, by Chris Quigg, Benjamin/Cummings, 1983, ISBN 0-8053-6020-4 (also available in paperback).

4. Useful supplementary text: *Heavy Flavour Physics*, Proc. 55th Scottish Universities Summer School, St. Andrews, 7–23 Aug 2001, edited by C. T. H. Davies and S. M. Playfer, Institute of Physics, 2002, ISBN 0-7503-0867-2 (paper).

5. Available on the Web: J. Rosner, "The Standard Model," `http://hep.uchicago.edu/~rosner/lects.pdf`

6. Useful for students with a theoretical background: *An Introduction to Quantum Field Theory*, by Michael E. Peskin and Daniel V. Schroeder, Addison-Wesley, 1995, ISBN: 0-201-50397-2.

7. Useful for students with an experimental background: *Quantum Field Theory*, by F. Mandl and G. Shaw, Wiley-Interscience, 1984, ISBN: 0 471 90650 6 (paper).

SYLLABUS

Week	Dates	Subject
1	3/27, 3/29	Introduction; quarks and leptons
2	4/3, 4/5	Particle detectors; quarks and SU(3)
3	4/10, 4/12	Lorentz group; Dirac equation
4	4/17, 4/19	Quantizing fields; Dyson expansion
5	4/24, 4/26	Feynman rules; e^+e^- annihilation
6	5/1, 5/3	Asymptotic freedom; electroweak theory
7	5/8, 5/10	Deep inelastic scattering; neutral currents
8	5/15, 5/17	Electroweak measurements; Higgs boson
9	5/22, 5/24	Quark mixing and CP violation
10	5/29, 5/31	Neutrinos; beyond the Standard Model

COURSE WEB ADDRESS:

`http://hep.uchicago.edu/~rosner/p363`